

PTO/SB/54/PCY (12-04)

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**PETITION FOR REVIVAL OF AN INTERNATIONAL APPLICATION FOR PATENT
DESIGNATING THE U.S. ABANDONED UNINTENTIONALLY UNDER 37 CFR 1.137(b)**

Docket Number
(Optional)
22188/06985

First Named Inventor: Timkos, Jared et al.

International (PCT) Application No.: PCT/US03/01351

U.S. Application No.: not yet assigned
(if known)

Filed: January 17, 2003

Title: BALL VALVE WITH SINGLE PIECE PACKING

Attention: PCT Legal Staff
Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

The above-identified application became abandoned as to the United States because the fees and documents required by 35 U.S.C. 371(c) were not filed prior to the expiration of the time set in 37 CFR 1.495(b) or (c) as applicable. The date of abandonment is the day after the date on which the 35 U.S.C. 371(c) requirements were due. See 37 CFR 1.495(h).

APPLICANT HEREBY PETITIONS FOR REVIVAL OF THIS APPLICATION

NOTE: A grantable petition requires the following items:

- (1) Petition fee
- (2) Proper reply
- (3) Terminal disclaimer with disclaimer fee which is required for all international applications having an international filing date before June 8, 1995; and
- (4) Statement that the entire delay was unintentional

1. Petition fee
☐ Small entity - fee \$ _____ (37 CFR 1.17(m)). Applicant claims small entity status.
See 37 CFR 1.27.

- ☒ Other than small entity - fee \$ 1,580 (37 CFR 1.17(m))
Please charge any fee deficiencies and credit any overpayments to
Deposit Account No.: 03-0172, Order number 22188/06985.

2. Proper reply

- A. The proper reply (the missing 35 U.S.C. 371(c) requirement(s)) in the form of
Entry into U.S. National Phase (identify type of reply):

☐ has been filed previously on _____

☒ is enclosed herewith.

[Page 1 of 2]

This collection of information is required by 37 CFR 1.137(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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3. Terminal disclaimer with disclaimer fee

☒ Since this international application has an international filing date on or after June 8, 1995, no terminal disclaimer is required.

☐ A terminal disclaimer (and disclaimer fee (37 CFR 1.20(d)) of \$ _____ for a small entity or \$ _____ for other than a small entity) disclaiming the required period of time is enclosed herewith (see PTO/SB/63).

4. Statement. The entire delay in filing the required reply from the due date for the required reply until the filing of a grantable petition under 37 CFR 1.137(b) was unintentional.

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Signature

Leonard L. Lewis

March 4, 2005

Date

31,176

Typed or Printed Name

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Registration Number, if applicable

216-622-8200

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Enclosures: ☒ Response Entry into U.S. National Phase☒ Fee Payment☐ Terminal Disclaimer☒ Other (please identify): Postcard

PTO-1390 (Rev. 02-2005)

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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A SUBMISSION UNDER 35 U.S.C. 371**ATTORNEY'S DOCKET NUMBER
22188/06985

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

PRIORITY DATE CLAIMED
18/01/2002INTERNATIONAL APPLICATION NO.
PCT/US03/01351INTERNATIONAL FILING DATE
17/01/2003TITLE OF INVENTION
BALL VALVE WITH SINGLE PIECE PACKINGAPPLICANT(S) FOR DO/EO/US
Timko, Jared et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a submission under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a submission under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☒ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A preliminary amendment.
14. ☐ An Application Data Sheet under 37 CFR 1.76.
15. ☐ A substitute specification.
16. ☐ A power of attorney and/or change of address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 37 CFR 1.821-1.825.
18. ☐ A second copy of the published International Application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information: check, postcard, Petition for Revival, courtesy copy of published application.

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering information, preparing, and submitting the completed form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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U.S. APPLICATION NO. (if known, see 37 CFR 1.5)		INTERNATIONAL APPLICATION NO. PCT/US03/01351		ATTORNEY'S DOCKET NUMBER 22188/06985	
The following fees have been submitted				CALCULATIONS	PTO USE ONLY
21.	<input checked="" type="checkbox"/>	Basic national fee..... \$300		\$ 300	
22.	<input checked="" type="checkbox"/>	Examination fee If International preliminary examination report prepared by USPTO and all claims satisfy provisions of PCT Article 33(1)-(4)..... \$100 All other situations..... \$200		\$ 200	
23.	<input checked="" type="checkbox"/>	Search fee Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority..... \$100 International Search Report prepared and provided to the Office..... \$400 All other situations..... \$500		\$ 400	
TOTAL OF 21, 22 and 23 =				\$ 900	
<input type="checkbox"/> Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing or computer program listing filed in an electronic medium). The fee is \$250 for each additional 50 sheets of paper or fraction thereof.					
Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof (round up to a whole number)		RATE	
- 100 =	/50 =			x \$250	\$
Surcharge of \$130.00 for furnishing the oath or declaration later than 30 months from the earliest claimed priority date (37 CFR 1.492(h)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	34 - 20 =	14	x \$ 50	\$ 700	
Independent claims	7 - 3 =	4	x \$200	\$ 800	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$360	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 2,400	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by 1/2.					
SUBTOTAL =				\$ 2,400	
Processing fee of \$130.00 for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)).				\$	
TOTAL NATIONAL FEE =				\$	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$ 40	
TOTAL FEES ENCLOSED =				\$ 2,440	
				Amount to be refunded:	\$
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a.	<input checked="" type="checkbox"/>	A check in the amount of \$ 3900 to cover the above fees is enclosed.			
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NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.					
SEND ALL CORRESPONDENCE TO:					
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Robert Watts
Signature

March 4, 2005
Date

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Typed Name

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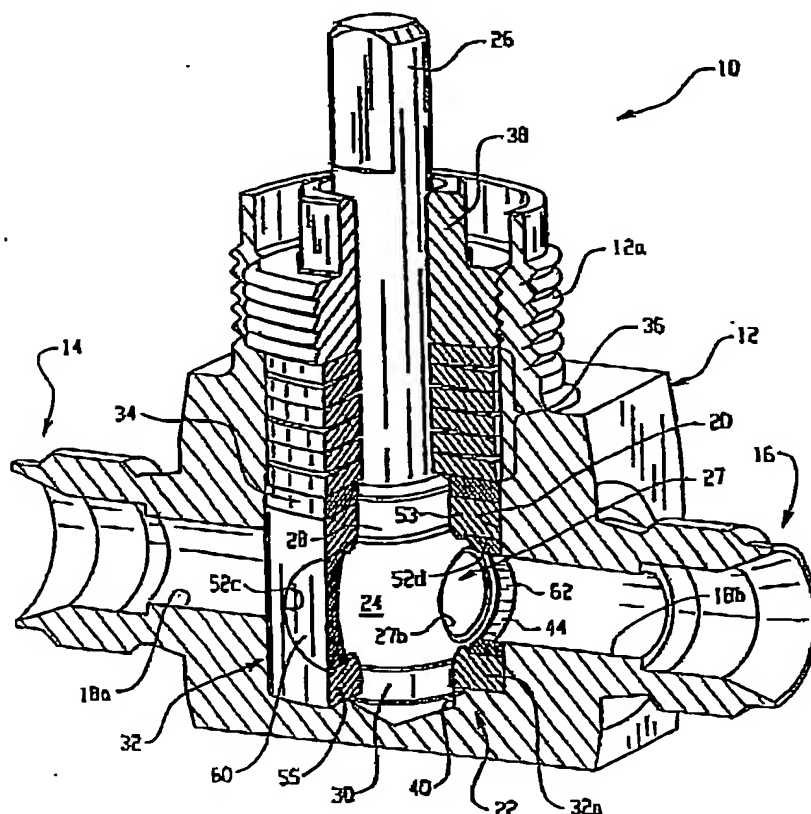
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[Continued on next page]

(54) Title: BALL VALVE WITH SINGLE PIECE PACKING



(57) Abstract: A ball valve includes a valve element (22) and a single piece packing (32) that seals the valve element within a valve cavity (20). The single piece packing is installed over the valve element at room temperature or may be molded thereon. The valve element may include a flow control element such as a ball (24) and upper (28) and lower (30) portions. The various dimensions of the valve element and packing are selected to facilitate room temperature assembly and to substantially reduce the volume of packing material, thereby improving the performance of the valve over wider temperature ranges and pressure ratings.

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Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Declaration under Rule 4.17:

— of inventorship (Rule 4.17(iv)) for US only

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BALL VALVE WITH SINGLE PIECE PACKING**Related Applications**

This application claims the benefit of United States Provisional patent application serial number 60/349,629 filed on January 18, 2002 for BALL VALVE WITH SINGLE PIECE
5 PACKING, the entire disclosure of which is fully incorporated herein by reference.

Technical Field Of The Invention

The subject invention relates in general to ball valves. More particularly, the invention relates to a new ball valve design and packing concepts that improve valve performance under higher and lower rated operating temperatures and thermal cycling.

Background of the Invention

10

Ball valves are well known in the art, and a highly successful commercially available ball valve is described in United States Patent No. 4,685,488 issued to Corbin et al. and owned by the assignee of the present invention, the entire disclosure of which is fully incorporated herein by reference.

15

Ball valves that use polymers for the ball packing material are usually limited in their rated or specified high and low temperature operating ranges at rated pressure. This is because the packing material expands and contracts at a different rate than other valve components which typically are made of stainless steel. At higher temperatures the packing material softens and tends to flow or creep and may become permanently deformed or otherwise damaged during
20 valve actuation at higher temperature. This damage to the packing can result in leakage, especially when the valve returns to ambient temperature. At colder temperatures, the packing material becomes harder and stiffer and there may also, in some cases, be a decreased sealing stress on the packing due to packing shrinkage at lower temperatures. This loss of stress can produce leakage at lower temperatures. Although it is known to incorporate live load packing
25 techniques into ball valves to increase the rated operating temperature range of the valve, the

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overall improvement is still limited by the temperature response characteristics of the packing material itself.

The need continues to exist for a ball valve having a polymer type ball packing material with increased rated operating temperature range and temperature cycling performance at rated
5 pressure.

Summary of the Invention

The present invention contemplates a ball valve arrangement in which a single piece packing may be installed onto a valve element within a temperature range so that the mechanical properties of the packing material are substantially unchanged. The present invention further
10 contemplates methods of assembly. Still further the invention contemplates a valve element and packing wherein various dimensions are selected to improve the rated operating temperature range and cycle life of the valve such as by reducing the volume of packing material and providing a more uniform distribution of load on the packing after installation into the valve. Various aspects of the invention may optionally be used with a multi-piece packing. Still further,
15 the invention contemplates a ball and trunnion design that allows a ball valve element to axially float or shift when the valve element packing expands and contracts under temperature changes. Another aspect of the invention relates to the use of a live load applied to the valve element packing in combination with the axial float of the valve element.

These and other aspects and advantages of the invention will be readily understood and
20 more fully described in the following detailed description of various embodiments and alternatives of the invention when read in view of the accompanying drawings.

Brief Description Of The Drawings

Fig. 1 is an isometric cross-section view of a ball valve incorporating various aspects of the present invention (valve illustrated in open position);

25 Fig. 2 is a vertical cross-section in elevation of the valve of Fig. 1;

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Fig. 3 illustrates a valve element in accordance with the invention in elevation;

Fig. 4 is an exploded isometric of a single piece packing and support rings used in the embodiment of Fig. 1;

Fig. 4A is a partial cross-section of the packing of Fig. 4;

Fig. 5 is an isometric cutaway of another embodiment of the invention with a third flow port added; and

Fig. 6 is an isometric cutaway of another embodiment of the invention using a non-spherical ball valve element.

Detailed Description Of The Invention

With reference to the drawings, the present invention contemplates a ball valve design with improved temperature performance ratings at rated pressure. The improved temperature performance includes higher and lower rated or specified temperature ranges, as well as under thermal cycling. The present invention is described herein with reference to a particular ball valve design, however, those skilled in the art will readily appreciate that the various aspects of the invention may be incorporated into different ball valve configurations. Furthermore, while the exemplary embodiment herein includes several different aspects of the invention, the invention should not be construed in a limiting sense. Rather, some or all of the aspects and features of the present invention may be incorporated into a ball valve design either individually or in various combinations or sub-combinations and still be within the scope and spirit of the present invention as set forth in the appended claims. Furthermore, while various alternative embodiments may be described herein, such description is not intended to be an exhaustive list of every alternative embodiment that may be readily apparent to those skilled in the art in view of the teachings herein. The present invention contemplates alternative embodiments within the scope of the appended claims, whether expressly described herein or not. Although the

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exemplary embodiment illustrates a single piece or unitary packing, various aspects of the invention may also be utilized with multi-piece packings.

Various aspects of the present invention then are illustrated in the drawings as being embodied in a ball valve 10 having a valve body 12 with appropriate end fitting connections 14 and 16 for installing the valve 10 in a fluid circuit. Respective bores 18a and 18b extend from each end fitting connection 14, 16 through the valve body 12 and open to a central ball receiving valve cavity 20 formed therebetween in the valve body 12. A valve element assembly 22 is disposed partly within and extends from the valve cavity 20. The valve element assembly 22 includes a flow control ball 24 that is preferably but not necessarily machined integral with a valve actuator stem 26. The ball 24 has a central fluid passageway or bore 27 machined therethrough and forms openings or stem orifices 27a and 27b that align with the valve body bores 18a and 18b to permit fluid flow therebetween when the valve is in the open position illustrated in the drawings. When the stem 26 and ball 24 are rotated to a position such that the orifices 27a and 27b are out of alignment with the valve body bores 18a, 18b, the valve is in a closed position and fluid flow is blocked. For example, the valve 10 may be closed by a ninety degree (quarter-turn) rotation of the ball 24.

The valve stem 26 extends through an optionally externally threaded integral bonnet 12a of the valve body 12. The stem 26 may either include a handle (not shown) for manual actuation or may be coupled to a valve actuator (not shown) such as an electric or pneumatic or hydraulic actuator, for example. Rotation of the stem 26 about its longitudinal axis X causes rotation of the ball 24 within the valve cavity 20 to open and close the valve.

The valve stem 26 further includes an upper trunnion 28 and a lower trunnion 30. The upper and lower trunnions 28, 30 along with a valve packing 32, help to align and journal the valve element 22 within the valve cavity 20. In accordance with one aspect of the invention, at room temperature a rather close or interference fit is provided between the internal surface of the

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packing 32 and the outside surfaces of the ball 24 and the trunnions 28, 30. Additionally, after the valve element assembly 22 is installed and fully compressed in the valve body cavity 20, there is at room temperature an interference fit between the outer surface of the packing 32 and the surface of the cavity 20 both in the spherical portion surrounding the ball as well as the portions that receive the trunnions. These diametrical and trunion interference fits provide for a greater and more evenly distributed sealing force or pressure between the packing 32 and the stem surfaces 24, 28 and 30 (i.e. the ball and trunion surfaces) with less live loading required on the packing 32 as compared to prior art valves.

In accordance with one aspect of the invention, the valve packing 32 provides a fluid tight seal between the stem surfaces 24, 28 and 30 and the valve body 12. The packing 32 is stationary, in this embodiment, relative to rotation of the valve stem 26 and ball 24 during valve actuation. In its preferred but not exclusive form, and with reference to Fig. 4, the packing 32 is a single piece packing meaning that the packing is a unitary structure that is press fit assembled with the valve stem 26 to form the valve element assembly 22 prior to installing the valve element assembly 22 in the valve body 12. The packing 32 is preferably although not necessarily made of perfluoroalkoxy (PFA) material and may be made by conventional machining or molding processes. Other suitable materials for the packing 32 include but are not limited to ultra-high molecular weight polyethylene, PTFB (polytetrafluoroethylene) and variants of PTFE such as filled PTFB, polyetheretherketone (PEEK), filled PFA or fluorinated ethylene propylene. In some applications it may also be desirable to over-mold the single piece packing in place on the trunnions and ball.

The single piece packing 32 is generally cylindrical in shape and includes a central longitudinal bore 50. This bore 50 is sized relative to the outer diameter of the ball 24 and the trunnions 28, 30 so as to have an interference fit therewith at room temperature but at the same time to be able to be snap or press fit assembled at room temperature over the ball 24 and

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trunnions 28, 30 using an appropriate tool. As best illustrated in Fig. 4A, the packing interior surface 51 is formed with a contour or profile that generally conforms to the stem profile, in particular the ball 24 and the trunnions 28, 30. Thus, in the embodiment wherein the valve element is a spherical ball, the interior surface 51 is generally spherical and sized to have an interference fit with the ball 24. The upper and lower portions 53 and 55 of the interior portion of the packing 32 are cylindrical to conform with and appropriately sized to have an interference fit with the upper and lower trunnions 28, 30 respectively. It should be noted however, that the valve element need not be a spherical ball as in the drawings herein, but may have other profiles such as an oval "football" shape or other profile suitable to a particular application. Fig. 6 herein illustrates an example of such a valve element profile. In such cases, the packing 32 will be made to have a generally conforming profile. Furthermore in some applications the interior surface 51 need not strictly conform to the shape or profile of the stem prior to installation of the stem into the packing, but upon final compressed assembly into the valve body will substantially conform to the stem profile so as to adequately seal the ball and trunnions.

The packing 32 further includes a number of openings 52a-d formed in the cylindrical wall 54 of the packing 32. Pairs of these openings, for example 52a/52d or 52b/52c are diametrically opposed to each other so as to concentrically align with the orifices 27a and 27b of the ball 24. In the illustrated example, openings 52b and 52c align with the passageway 27 when the valve is in the closed position and openings 52a and 52d align with the passageway 27 when the valve is in an open position. The lower port 50a of the bore 50 may also be used as an opening to a bottom mounted port formed in the stem 26, as illustrated in Fig. 5 and as will be described hereinafter.

For the openings that are used for fluid flow when the valve 10 is in the open position (for example, openings 52a and 52d in Fig. 4), support rings 42, 44 may be provided that are slip fit inserted into these openings. The support rings 42, 44 include through holes 42a and 44a

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respectively for permitting fluid flow therethrough when the valve 10 is in its open position. The support rings 42, 44 support the packing 32 in the area of the openings 52 to prevent extrusion of the packing into the passageway 27 or the ports 27a and 27b. To enhance this effect, the support rings 42, 44 may be provided with internal flats 62 that generally align with the X axis when the rings are installed in the packing. These flats increase the rigidity of the support rings to increase their support of the packing material under load.

Each of the openings 52a-d may include an internal circumferentially raised lip 64. This lip prevents a support ring 42, 44 from inadvertently contacting the ball 24 outer surface when the stem 26 is rotated.

When various of the openings 52 (such as, for example, opening 52c or 52b) are not to be used for a particular valve configuration (for example, only two of the openings 52 are used for a two port valve) each such unused opening is plugged with a suitable disk or plug 60 (Fig. 4). Each disk 60 slip fits into its respective opening 52. The disks 60 support the packing 32 against cold flow extrusion and creep in the region of the passageway 27.

The disks 60 (and the support rings 42, 44) may be made of any suitable material, such as for example, stainless steel, and preferably but not necessarily are curved or otherwise shaped to conform on their outside surface to the outside profile of the packing 32, and on their inside surface to conform to the inside profile of the packing 32 (note in the illustrated embodiment that the packing 32 has a cylindrical outside surface profile and both a spherical portion and cylindrical portion to its inside surface profile). The disks 60 sit against the inner lip 64 in the respective opening 52 so as not to contact the ball surface.

In order to install the packing 32 onto the valve element 22 (other than for an over-molded process), the packing 32 is assembled with the integral ball and stem by press fit, snapped or otherwise slipped into place on the stem 26 over the upper or lower trunnion 28, 30 and over the outer surface or diameter of the ball 24 which necessarily is larger in diameter than

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either trunnion 28, 30. If the packing 32 is thus too bulky, it will be too stiff and inflexible at room temperature to slip onto the ball 24 to the position illustrated in the drawings. In accordance then with one aspect of the invention, the valve element 22 is machined so that the diameter D1 of the ball 24 is only slightly greater than either or both of the respective diameters D2, D3 of the trunnions 28, 30 (see Fig. 3). The trunnion diameters D2 and D3 may be the same or different depending on the selected valve design.

In prior art ball valves, the trunnion to ball diameter ratio (either D2/D1 or D3/D1) typically is 0.3-0.65. In accordance with the invention the ratio should be preferably about 0.7 to about 0.9 and more preferably about .70 to about .76. This substantially higher ratio (enlarged trunnion relative to the ball diameter) substantially reduces the mass volume of the packing 32 because there is less gap between the trunnions and the valve body cavity 20. The reduced mass volume of the packing 32 also allows the packing 32 to be more flexible at room temperature thus allowing the packing 32 to be snap fit or press fit onto the valve element 22 at room temperature. Since the ball 24 is only slightly larger than the trunnions 28, 30, the more flexible packing 32 can easily be installed onto the valve element 22 at room temperature prior to installing the valve element 22 into the valve body 12. This greatly simplifies assembly thus reducing assembly time and cost.

As used herein, by "room temperature" is simply meant that range of temperatures within which the packing material is not significantly changed in terms of the packing material's properties such as elasticity characteristics. An exemplary but not required range for room temperature assembly is about 65-100 °F. In other terms, "room temperature" is that range of temperatures in which the packing remains substantially in its normal condition without substantially altering the mechanical properties of the packing material such as, for example, its elasticity.

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It is noted at this point that an alternative process for providing a single piece packing on a valve stem/ball/trunnion element is to over-mold the packing in place. In other words, directly mold the packing onto the stem using conventional molding techniques. An over-mold process eliminates the assembly step of slipping the packing 32 into position on the stem. However, other benefits and aspects of the present invention that result in a reduction in packing mass volume may also be realized with a single piece packing that is over-molded in place.

Completing the description of the valve 10 structure, a packing gland 34 is provided axially adjacent the valve packing 32 upper surface. This packing gland 34 may be made of stainless steel for example, and functions to help contain the packing 32 at elevated temperatures and also serves as a thrust washer for live loading the packing 32. The diametric clearance between the inside diameter of the gland 34 and the outside diameter D2 of the upper trunnion 28, as well as the diametric clearance between the outside diameter of the gland 34 and the body cavity 20 diameter, are controlled so that the gland 34 contains the packing 32 thereby reducing or minimizing creep or extrusion at elevated temperatures, as well as to function as a thrust washer to load the packing 32. A number of disk springs 36 or other suitable load applying members are axially stacked (with reference to the longitudinal axis X of the stem 26) and compressed against the gland 34. The load members 36 apply a live load to the gland 34 and the packing 32 so as to maintain adequate sealing compression of the packing 32 at higher and lower temperatures. By "live load" is meant that the load members 36 continue to apply a load force against the gland 34 and the packing 32 when the valve is operated at a temperature above or below room or ambient temperature. The load members 36 are compressed and held in place by a threaded packing bolt 38 that is threadably installed in the upper or stem receiving extension 12a of the valve body 12.

The lower trunnion 30 axially extends below the bottom 32a of the packing 32 into a counterbore 40 formed in the valve body 12. Preferably there is a close clearance fit between the

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lower trunnion 30 and the diameter of the counterbore 40. This close clearance fit helps to contain the lower portion of the packing 32 against creep or extrusion, maintains contact stress between the packing 32 and the ball 24, and maintains contact stress between the packing 32 and the roughened surface of the valve cavity 20 (roughened, for example, by abrasion sand blasting) to prevent the packing 32 from rotating within the valve body 12 during valve actuation. The lower portion packing 32a containment reduces packing stress relaxation at non-ambient and particularly lower temperatures. The upper and lower packing containment features allow the valve element 22 to axially move to compensate for packing 32 expansion and contraction over thermal cycles.

10 The packing 32 openings 52a and 52d concentrically align respectively with the ball fluid passageway stem orifices 27a and 27b when the valve 10 is in the fully open position. At the orifices 27a and 27b the retaining or support rings 42, 44 and disks 60 are positioned within the packing 32 openings 52a-d and help contain the packing 32 to prevent extrusion of packing material into the ball passageway 27 and orifices 27a and 27b.

15 The valve is assembled as follows. The support rings 42, 44 and disks 60 when appropriate are inserted into the packing 32 openings 52a-d. The rings and disks thus also help support the packing 32 during the assembly process. The packing 32 is then installed on the valve stem 26 as described herein above. The valve element assembly 22 that includes the ball/stem 24/26, the one piece packing 32 and the support rings 42, 44 (and disks 60 when used) is installed into the valve cavity 20 of the valve body 12. A suitable tool may be used to align and compress the assembly 22 as it is inserted into the valve body. The gland 34 and the load members 36 are either installed with the packing 32 prior to installation of the valve element assembly into the valve body 12 or may be installed after the valve element assembly is installed in the valve body. The packing bolt 38 is then screwed into the valve body stem extension 12a to

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complete the assembly. The bolt 38 is tightened to a suitable torque or number of turns to effect the desired load on the packing 32.

In accordance with another aspect of the invention, reducing the packing volume or amount of material that comprises the single piece packing, can be realized by reducing the packing height ("H" in Fig. 3) to the packing outside diameter D4 ratio (H/D4). In Fig. 3 the packing height is noted "H". This results in less packing material for the packing 32, in a manner similar to increasing the trunnion to ball diameter ratio described hereinabove. With less packing material needed to adequately seal the valve, there is less adverse effects noted from temperature variations at high and low temperature and thermal cycling. In a typical prior art ball valve the packing height to packing outer diameter ratio was in the range of 0.9 to 1.1 whereas with the present invention the packing height to packing outer diameter ratio is from about 0.75 to about 0.85 with a preferred value of about 0.8. The overall effect of controlling these ratios is that packing volume can be reduced about 15% to about 50% compared to prior art ball valves that use conventional ratios of trunnion diameter to the ball diameter, or packing height to packing outside diameter, thus providing substantially increased thermal performance.

It is important to note that the various ratios described herein may vary depending on the size of the valve. For example, the exemplary ratio ranges for D3/D1 herein are provided for a ball valve element used with a 1/4 inch tubing system. In accordance with the invention then, the ratio D2/D1 or D3/D1 are selected so as to facilitate the assembly of the packing onto the valve element at room temperature. Still further, the ratio of H/D4 is selected so as to reduce the packing volume and thereby increase the thermal performance.

The enlarged trunnion concept provides a more efficient live loading of the packing 32 transmitted through to the lower portion of the packing. In a small trunnion design of the prior art, much of the vertical loading is carried by the ball portion 24 of the valve stem. In contrast, the present invention with the enlarged trunnion diameter focuses the live load toward loading

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the packing and transmitting that load and resulting packing sealing stress to the lower portion of the packing, thereby providing a much more evenly distributed and effective loading stress to maintain a seal.

We have discovered that in some situations the support rings 42, 44 can crush vertically either from thermal expansion or excessive loads applied during assembly after, for example, packing servicing. Improved resistance to vertical crushing is realized in accordance with the invention by providing the vertical flats 62 to the inside diameter of the support rings 42, 44. The flats should be vertically aligned with the centerline (X axis in the drawings) of the valve 10. These flats may also function as orientation guides to assure proper orientation of the rings during installation. A recessed groove or other suitable marking 63 may be used on the disks 60 to assure proper orientation of the disks 60.

To prevent clipping of the packing material by the edge of the stem orifices 27a and 27b during valve actuation (ball rotation), preferably but not necessarily, an edge break is provided around each of the stem orifices 27a, 27b.

In accordance with another aspect of the invention, it will be noted that the stem 26 and integral ball 24 are axially (along the X axis) unconstrained by use of the live load disk springs 36 and the lower counterbore 40. The stem 26 thus is free to shift under temperature variations that cause expansion and contraction of the packing 32. This helps maintain a consistent and effective load on the packing 32.

Fig. 5 illustrates another embodiment of a valve 68 that incorporates the present invention. In this example, a bottom port (not shown) is formed in the ball 24 that is in fluid communication with a third fitting 70. The other elements of the valve may be the same as in the above described embodiments.

The invention has been described with reference to the preferred embodiment. Modifications and alterations will occur to others upon a reading and understanding of this

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specification. It is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

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CLAIMS

WE CLAIM:

1. A valve comprising:
a valve body having a valve cavity therein;
5 a valve element for controlling flow through the valve based on rotational position
of the valve element about an axis; and
a single piece packing that surrounds said valve element and seals said valve
element within said valve cavity;
said single piece packing being dimensioned to be installed on said valve element
10 within a room temperature range.
2. The valve of claim 1 wherein said room temperature range is about 65-100 °F.
3. The valve of claim 1 wherein said packing has a generally cylindrical outer
surface defined by a height H and an outer diameter D4, said packing having a ratio H/D4 of
about 0.75 to about 0.85.
- 15 4. The valve of claim 3 wherein said ratio H/D4 is about 0.8.
5. The valve of claim 1 wherein said valve element comprises a ball and adjacent
upper and lower trunnions; said ball having an outer diameter D1 and at least one of said
trunnions having an outer diameter D3; wherein said valve element has a ratio D3/D1 of about
0.7 to about 0.9.
- 20 6. The valve of claim 5 wherein said ratio D3/D1 is about 0.8.
7. The valve of claim 1 wherein said packing has a generally cylindrical outer
surface defined by a height H and an outer diameter D4, said packing having a ratio H/D4 of
about 0.75 to about 0.85; and wherein said valve element comprises a ball and adjacent upper and
lower trunnions; said ball having an outer diameter D1 and at least one of said trunnions having
25 an outer diameter D3; wherein said valve element has a ratio D3/D1 of about 0.7 to about 0.9.

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8. The valve of claim 7 wherein said ratio $H/D4$ is about 0.8 and said ratio $D3/D1$ is about 0.8.

9. The valve of claim 1 wherein said packing comprises a polymer.

10. The valve of claim 9 wherein said polymer is selected from the group comprising
5 polytetrafluoroethylene (PTFE), polyethylene, polyetheretherketone (PEEK) and fluorinated ethylene propylene.

11. The valve of claim 1 wherein said valve element comprises a non-spherical flow control element.

12. The valve of claim 1 wherein said packing has an inner surface that forms an
10 interference fit with said valve element when said packing is installed thereon prior to loading said packing within said valve body.

13. The valve element of claim 1 wherein said packing has an interference fit with said valve cavity when said packing is installed on said valve element and inserted into said valve cavity prior to loading said packing within said valve cavity.

14. A method for assembling a valve comprising the steps of:
15 forming a one piece packing adapted to seal a valve element within a valve cavity; and installing said packing onto said valve element within a temperature range for which mechanical properties of the packing are substantially unchanged.

15. The method of claim 14 wherein said step of forming said packing comprises the
20 step of machining said packing.

16. The method of claim 14 wherein said temperature range is selected so that the mechanical properties of the packing material are substantially unchanged as compared to the mechanical properties of the packing material at 70 °F.

17. A valve comprising:

25 a valve body having a valve cavity therein;

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a valve element for controlling flow through the valve based on rotational position of the valve element about an axis; and

a packing that surrounds said valve element and seals said valve element within said valve cavity; and

5 said valve element comprising a ball and adjacent upper and lower trunnions; said ball having an outer diameter D1 and at least one of said trunnions having an outer diameter D3; wherein said valve element has a ratio D3/D1 of about 0.7 to about 0.9.

18. The valve of claim 17 wherein said packing has a generally cylindrical outer surface defined by a height H and an outer diameter D4, said packing having a ratio H/D4 of
10 about 0.75 to about 0.85.

19. The valve of claim 17 wherein said packing comprises a polymer that is selected from the group consisting of: PFA, filled PFA, polytetrafluoroethylene (PTFE), filled PTFE, polyethylene, polyetheretherketone (PEEK) and fluorinated ethylene propylene.

20. The valve of claim 17 wherein said packing is dimensioned to be installed on said
15 valve element at a temperature below which said packing deforms.

21. The valve of claim 20 wherein said temperature is room temperature.

22. The valve of claim 17 wherein said packing is a single piece packing.

23. The valve of claim 17 wherein said packing is over molded onto said valve element.

20 24. A valve comprising:

a valve body having a valve cavity therein;

a valve element for controlling flow through the valve based on rotational position of the valve element about an axis; and

a packing that surrounds said valve element and seals said valve element within said
25 valve cavity; and

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said valve element comprising a ball and adjacent upper and lower trunnions;

wherein said packing has a generally cylindrical outer surface defined by a height H and an outer diameter D4, said packing having a ratio H/D4 of about 0.75 to about 0.85.

25. The valve of claim 24 wherein said ball has an outer diameter D1 and at least one of said trunnions has an outer diameter D3; wherein said valve element has a ratio D3/D1 of about 0.7 to about 0.9.

26. The valve of claim 24 wherein said packing is a single piece packing.

27. The valve of claim 24 wherein said packing is a multi-piece packing.

28. The valve of claim 24 wherein said packing is installed onto said valve element at room temperature.

29. In combination, a valve element and a single piece packing therefore, wherein said packing is installed onto said valve element at room temperature.

30. The combination of claim 29 wherein said valve element comprises a ball and stem and with at least one trunnion adjacent said ball.

31. A valve comprising:

a valve body having a valve cavity therein;

a valve element for controlling flow through the valve based on rotational position of the valve element about an axis; and

a packing that surrounds said valve element and seals said valve element within said valve cavity;

said valve element comprising a ball and adjacent upper and lower trunnions; said ball having an outer diameter D1 and at least one of said trunnions having an outer diameter D3; wherein said valve element has a ratio D3/D1 that facilitates assembly of said packing onto said valve element at room temperature.

32. A valve comprising:

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a valve body having a valve cavity therein;

a valve element for controlling flow through the valve based on rotational position of the valve element about an axis; and

5 a packing that surrounds said valve element and seals said valve element within said valve cavity;

said valve element comprising a ball and adjacent upper and lower trunnions; said valve cavity being dimensioned to closely receive said valve element while permitting said valve element to axially shift to compensate for temperature effects on said packing.

33. The valve of claim 32 wherein said valve cavity comprises a reduced diameter
10 bore that receives said lower trunnion and prevents packing material from creeping below said lower trunnion.

34. The valve of claim 32 wherein said packing is live loaded.

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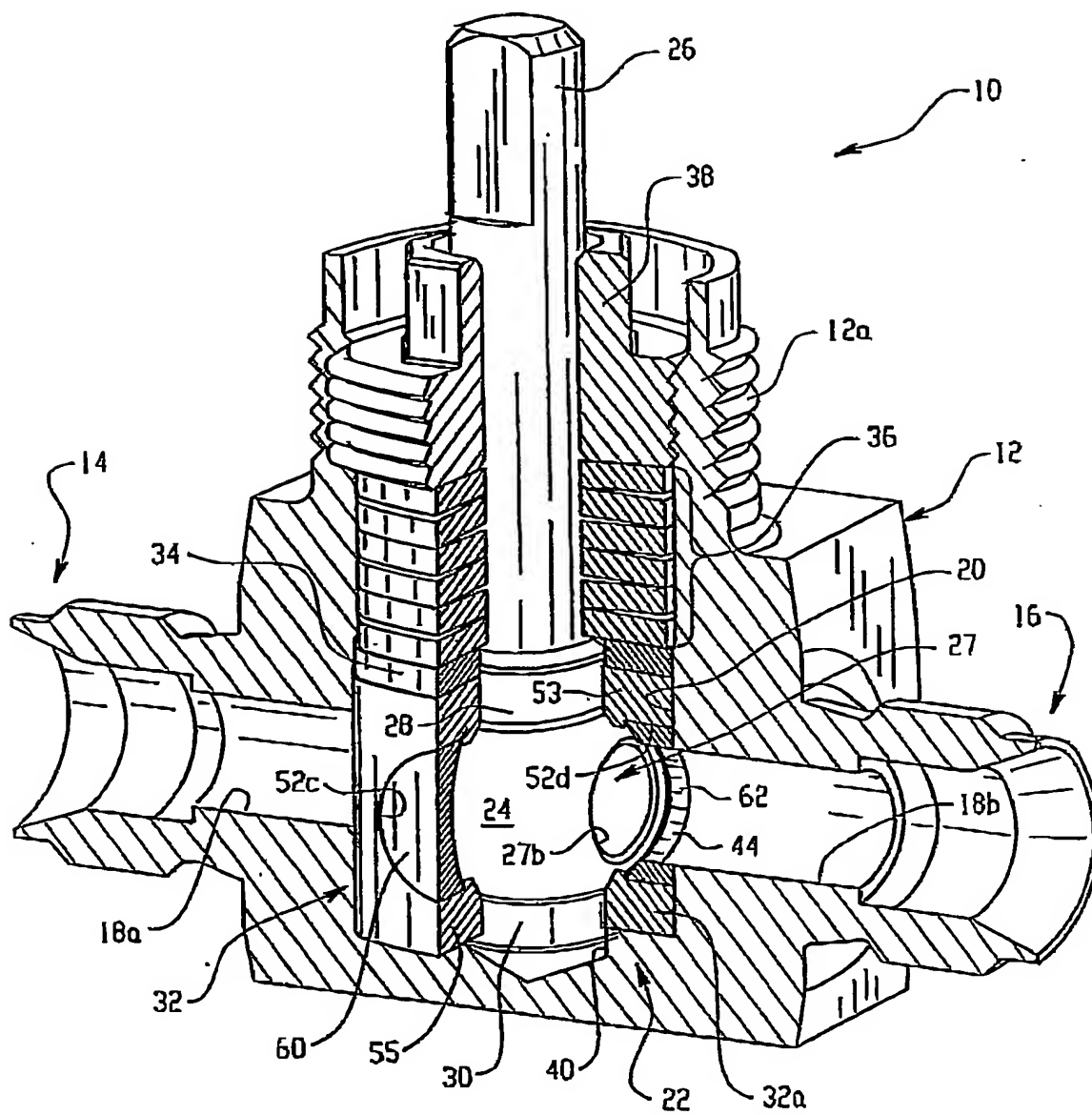


Fig. 1

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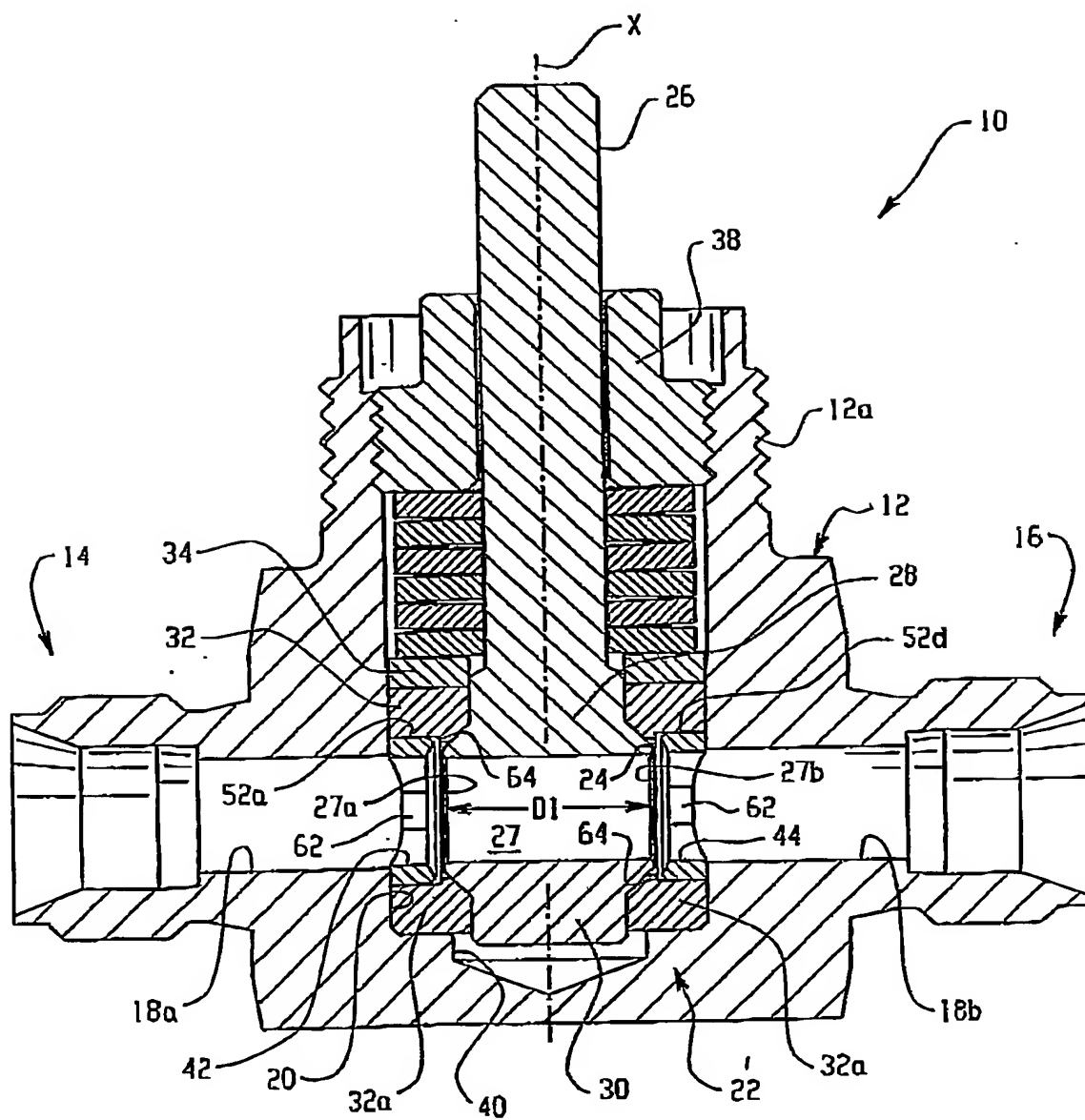
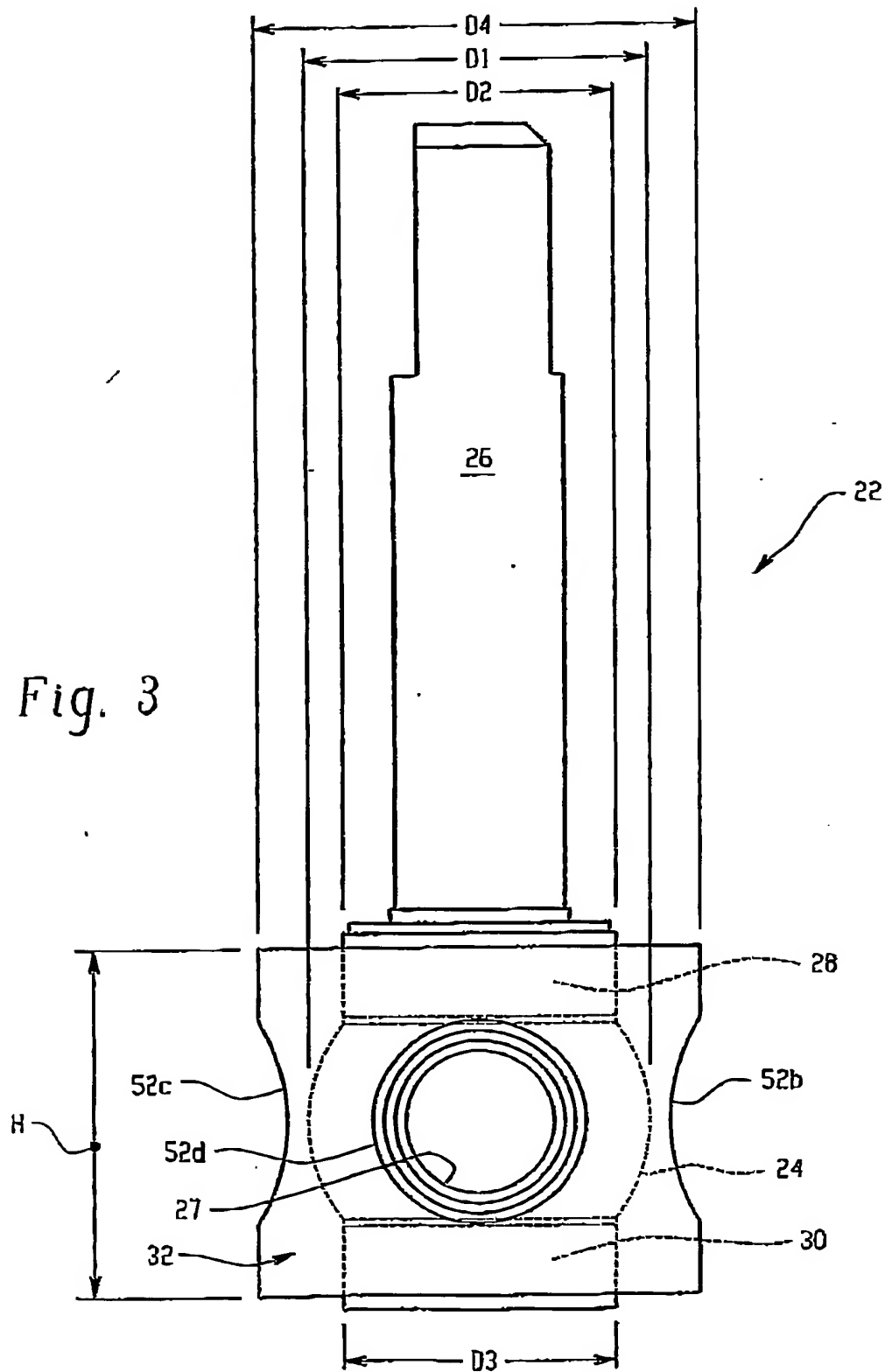


Fig. 2

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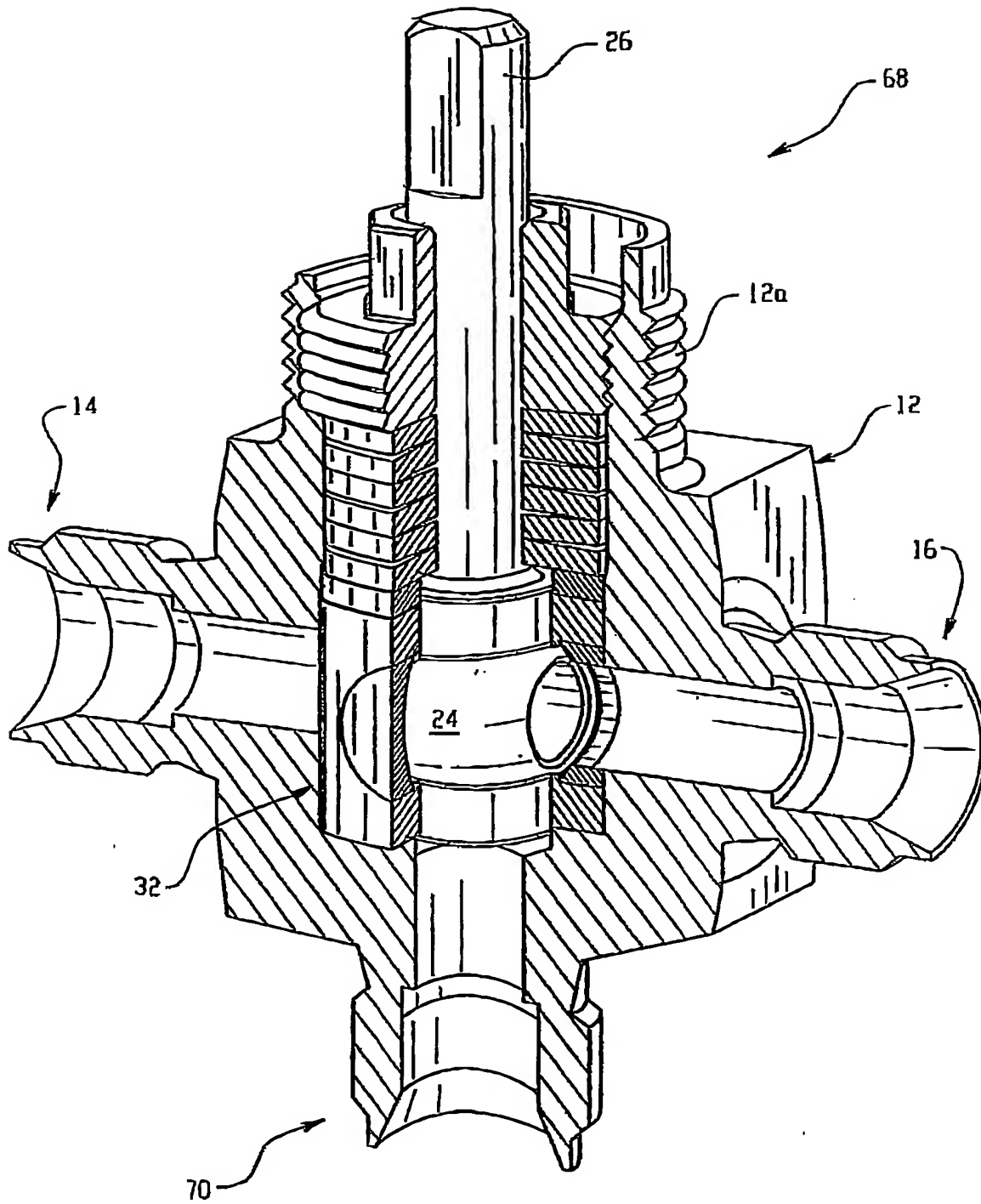


Fig. 5

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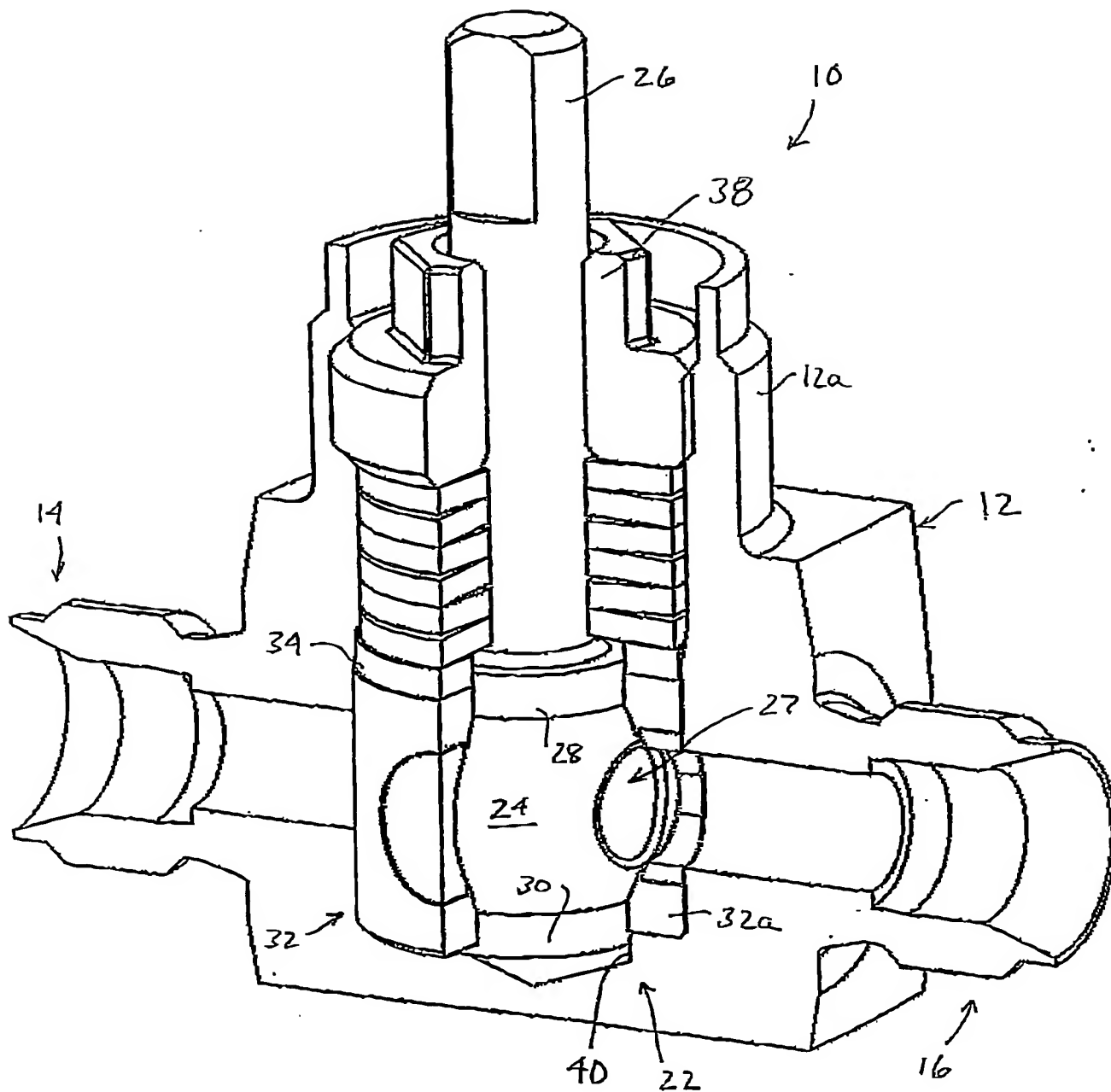


Fig. 6

NATIONAL SEARCH REPORT

Application No

PCT/US 03/01351

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16K5/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search limits used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 192 943 A (MOEN ALFRED M) 6 July 1965 (1965-07-06)	1-22, 24-26, 28-31
Y	column 2, line 38 -column 5, line 52; figures	23,27
Y	US 5 730 420 A (TOW JOHN P) 24 March 1998 (1998-03-24)	23
A	column 2, line 35 -column 2, line 43; figures	17,22
Y	DE 12 02 596 B (WHITEY RESEARCH TOOL CO) 7 October 1965 (1965-10-07)	27
A	column 2, line 25 -column 3, line 12; figures	1,3,4, 7-10, 17-21, 24,28

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

24 April 2003

Date of mailing of the international search report

14/05/2003

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Lanel, F-B

INTERNATIONAL SEARCH REPORT

Application No

PC. 03/01351

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 648 723 A (NELSON DONALD R ET AL) 14 March 1972 (1972-03-14) column 1, line 70 -column 2, line 41; claim 1; figures	1,2, 12-14, 16,29,30
X	US 5 595 206 A (SORIA VEGA SERGIO) 21 January 1997 (1997-01-21) column 2, line 35 -column 5, line 48; figures	17,19, 22,31, 32,34
A	US 4 685 488 A (CORBIN SUSAN E ET AL) 11 August 1987 (1987-08-11) cited in the application figures	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Application No

PCT/03/01351

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3192943	A	06-07-1965	NONE	
US 5730420	A	24-03-1998	NONE	
DE 1202596	B	07-10-1965	NONE	
US 3648723	A	14-03-1972	DE 2062989 A1 FR 2073889 A5 GB 1286615 A	24-06-1971 01-10-1971 23-08-1972
US 5595206	A	21-01-1997	NONE	
US 4685488	A	11-08-1987	AT 56511 T AU 6797187 A CA 1271107 A1 CN 87100623 A DE 3764813 D1 DK 61787 A EP 0233060 A2 HK 133693 A IE 870313 L JP 62266275 A NO 870424 A ZA 8700565 A	15-09-1990 13-08-1987 03-07-1990 19-08-1987 18-10-1990 08-08-1987 19-08-1987 10-12-1993 07-08-1987 19-11-1987 10-08-1987 30-09-1987

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OMB No. 0651-0027 (exp. 6/30/2005)

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Jared S. Timko, Thomas A. Lippucci, Eric M. Kvarda, Brandon J. Fry and James E. Gotch

Execution Date(s) August 12, 2004 and August 16, 2004

Additional name(s) of conveying party(ies) attached? ☐ Yes ☒ No

3. Nature of conveyance:

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Internal Address: _____

Street Address: 29500 Solon Road

City: Solon

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Country: U.S. Zip: 44139

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4. Application or patent number(s):

A. Patent Application No.(s)

☒ This document is being filed together with a new application.

B. Patent No.(s)

Additional numbers attached? ☐ Yes ☒ No

5. Name and address to whom correspondence concerning document should be mailed:

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Internal Address: Calfee Halter & Griswold LLP

Street Address: 800 Superior Ave., Ste. 1400

City: Cleveland

State: Ohio Zip: 44114

Phone Number: 216-622-8200

Fax Number: 216-241-0816

Email Address: llewis@calfee.com

6. Total number of applications and patents involved:

1

7. Total fee (37 CFR 1.21(h) & 3.41) \$ 40

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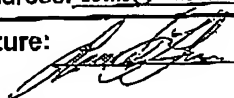
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a. Credit Card Last 4 Numbers _____
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Authorized User Name _____

9. Signature:



Signature

March 9, 2005
Date

Leonard L. Lewis, Reg. No. 31,176

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ASSIGNMENT

For good and valuable consideration received of the hereinafter named assignee, receipt of which is hereby acknowledged, we, the undersigned, Jared S. Timko, 7850 Champaign, Mentor, Ohio 44060, Thomas A. Lippucci, 73 E. Dartmoor Ave., Seven Hills, Ohio 44131, Eric M. Kvarda, 6490 Bryson Dr., Mentor, Ohio 44060, Brandon J. Fry, 10325 Penniman Dr., Chardon, Ohio 44024 and James E. Gotch, 8900 Riverwood Way, Kirtland, Ohio 44094, hereby assign all right, title and interest to Swagelok Company, an Ohio corporation, having a place of business at 29500 Solon Road, Solon, Ohio 44139, its successors and assigns, the entire right, title and interest, so far as concerns the United States and the Territories and Possessions thereof and all foreign countries, in and to the inventions in

BALL VALVE WITH SINGLE PIECE PACKING

as set forth in the following application United States Provisional patent application serial no. 60/349,629, filed on January 18, 2002, PCT application serial no. PCT/US03/01351, filed on January 17, 2003 and any and all other applications for Letters Patent on said inventions in the United States and in all countries foreign to the United States, including but not limited to all non-provisional, provisional, divisional, renewal, substitute, national stage, continuation, PCT and Convention applications based in whole or in part upon said inventions or upon said applications, and any and all Letters Patents and reissues and extension of Letters Patent granted for said inventions or upon said applications, and every priority right that is or may be predicated upon or arise from said inventions, said applications and said Letters Patent; said assignee being hereby authorized to file patent applications in any or all countries on any or all said inventions in the name of the undersigned or in the name of said assignee or otherwise as said assignee may deem advisable, under the International Convention or otherwise; the Commissioner of Patents of the United States of America and the empowered officials of all other governments being hereby authorized to issue or transfer all said Letters Patent to said assignee in accordance herewith; this assignment being under covenant, not only that full power to make the same is had by the undersigned, but also that such assigned right is not encumbered by any grant, license, or other right heretofore given, and that the undersigned will do all acts reasonably serving to assure that the said inventions, patent applications and Letters Patent shall be held and enjoyed by said

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Date: 8/12/04


Jared S. Timko

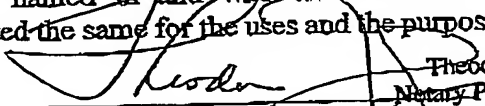
State of Ohio)

) SS:

County of LAKE)

On this 12th day of AUGUST, 2004, personally appeared before me, Jared S. Timko, to me known to be the person named in and who executed the above instrument, and acknowledged to me that he executed the same for the uses and the purposes therein mentioned.

Date: 8/12/04


Theodore J. Gausman
Notary Public, State of Ohio
My Commission Expires on 10/30/05
Recorded in Lake County

Date: 8/16/04


Thomas A. Lippucci

State of Ohio)

) SS:

County of LAKE)

On this 16th day of AUGUST, 2004, personally appeared before me, Thomas A. Lippucci, to me known to be the person named in and who executed the above instrument, and acknowledged to me that he executed the same for the uses and the purposes therein mentioned.

Date: 8/16/04


Theodore J. Gausman
Notary Public, State of Ohio
My Commission Expires on 10/30/05
Recorded in Lake County

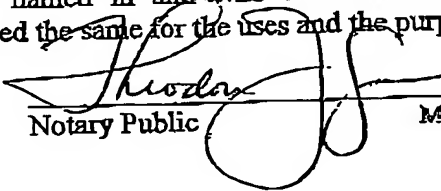
Date: 8/12/04
Eric M. Kvarda

State of Ohio)

) SS:

County of LAKE)

On this 12th day of AUGUST, 2004, personally appeared before me, Eric M. Kvarda, to me known to be the person named in and who executed the above instrument, and acknowledged to me that he executed the same for the uses and the purposes therein mentioned.

Date: 8/12/04
Notary Public

Theodore J. Gausman
Notary Public, State of Ohio
My Commission Expires on 10/30/05
Recorded in Lake County

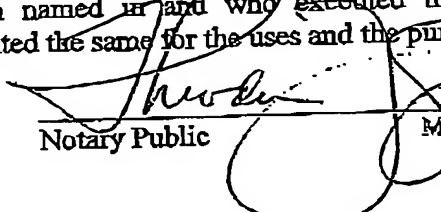
Date: 8-16-04
Brandon J. Fry

State of Ohio)

) SS:

County of CUYAHOGA)

On this 16th day of AUGUST, 2004, personally appeared before me, Brandon J. Fry, to me known to be the person named in and who executed the above instrument, and acknowledged to me that he executed the same for the uses and the purposes therein mentioned.

Date: 8/16/04
Notary Public

Theodore J. Gausman
Notary Public, State of Ohio
My Commission Expires on 10/30/05
Recorded in Lake County

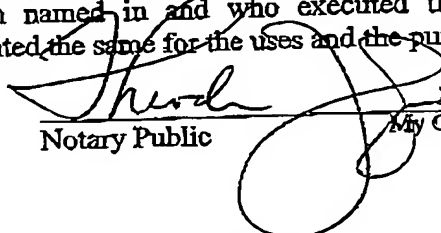
Date: 8-12-04
James E. Gotch

State of Ohio)

) SS:

County of LAKE)

On this 12th day of AUGUST, 2004, personally appeared before me, James E. Gotch, to me known to be the person named in and who executed the above instrument, and acknowledged to me that he executed the same for the uses and the purposes therein mentioned.

Date: 8/12/04
Notary Public

Theodore J. Gausman
Notary Public, State of Ohio
My Commission Expires on 10/30/05
Recorded in Lake County

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